reduction depends very much upon the material used, its thickness, and the frequency of the fields of interest.

[0015] Another commonly used shielding method, especially with electronic goods housed in plastic enclosures, is to coat the inside of the enclosure with a metallic ink or similar material. The ink consists of a carrier material loaded with a suitable metal, typically copper or nickel, in the form of very small particles. It is sprayed on to the enclosure and, once dry, produces a continuous conductive layer of metal, which can be electrically connected to the chassis ground of the equipment, thus providing effective shielding. This method, however, is only applicable if there are no sensitive parts within the enclosure, that would be contaminated when applying the conductive material. In particular, it is not suited for devices with optical components, where the optical transmissibility would be adversely affected by the conductive ink.

[0016] Small sized integrated camera devices, like those for camera mobile phones, should also be EMC shielded for improved image quality. It is known to put a conductive enclosure around the individual camera device after its complete assembly. This process is thus not compatible with a wafer scale production process. Furthermore, it is complicated to provide and attach the enclosure. On the other hand, also the method of spraying a conductive material on the inner surfaces of the device is not suited, because there are optical elements, like lenses, in the inside of the device that must not be covered with conductive material or otherwise contaminated.

BRIEF SUMMARY OF THE INVENTION

[0017] It is thus an object of the invention to provide an optical module for an electro-optical device, like for example a camera device, said module having an EMC shielding that is easy to manufacture, in particular in a mass production process at low costs.

[0018] It is a further object of the invention to provide a method for manufacturing a plurality of optical modules having an EMC shielding on wafer scale.

[0019] The optical module comprises at least one generally transparent lens substrate portion with at least one lens element, at least one spacer, and an electrically conductive shield which is integral part of the module.

[0020] In particular, the optical module comprises at least one lens substrate portion having a front surface and a rear surface, and at least one lens element attached to the at least one lens substrate portion, e.g. to the front surface and/or the rear surface. The optical module further comprises at least one spacer attached to said lens substrate portion. The spacer has a rear surface running generally in parallel to the rear surface of the lens substrate portion at a predetermined distance therefrom. The spacer also comprises an inner side surface extending between the rear surface of the lens substrate and the rear surface of the spacer. The spacer also comprises an outer side surface running generally in parallel to the inner side surface.

[0021] The optical module according to the invention is intended to be a part of an electro-optical device, wherein the electro-optical device comprises a functional element arranged on a base substrate portion. The electro-optical device may, for example, be a camera device having an image capturing element, e.g. a CMOS or CCD sensor. The optical module is intended to be placed on top of the base substrate portion, with the spacer keeping the lens substrate portion at a predetermined axial distance from the base substrate portion such that the functional element and/or the lens can be arranged in a cavity between these two substrate portions. In particular, the rear surface of the spacer faces the base substrate portion in the completed electro-optical device. It is, for example, directly attached to the base substrate portion or indirectly via an intermediate layer. The cavity mentioned above is thus defined by parts of the lens and base substrate portion and the inner side walls of the spacer.

[0022] The spacer can be part of a conventional baffle, e.g. can be constituted by the side walls of the baffle described with reference to the prior art. In a preferred embodiment of the invention, the spacer is a part of a generally flat spacer substrate or spacer layer attached to the rear surface of the lens substrate portion.

[0023] The invention is based on the finding that, in most cases, enclosing the complete optical module or even of the fully assembled electro-optical device with a separate enclosure constituting an EMC shielding is not necessary. Instead, effective shielding can be achieved by arranging a conductive element in the vicinity of the functional element (in the fully assembled electro-optical device), or in the vicinity of its intended position (in the optical module). The invention thus proposes to arrange an EMC shield as an integral part of the module, preferably in the region of the spacer. If more than one spacer or more than one layer of spacers is present, the shield is arranged at least in the region of the spacer or spacer layer constituting the bottom of the optical module and facing the functional element in the fully assembled electro-optical device.

[0024] It is preferred to use a spacer which is at least in parts electrically conductive, in particular by comprising a conductive coating on its inner and/or outer side surfaces or by being conductive itself. Though shielding in the region adjacent to the functional element (spacer region) should be sufficient for most purposes, further conductive parts could be arranged elsewhere to improve the shielding, in particular to form, in combination with the conductive spacer, a dome-like or cage-like electrically conductive shield for the functional element. The shield is preferably connected in a conductive manner to the base substrate portion in the fully assembled device.

[0025] The shield can be made of elements that are present anyway, in particular it may be a part of the spacer (coating thereon, or spacer made of a conductive material), and/or of an optically non-transmissive coating on the substrates used for beam shaping purposes.

[0026] According to a preferred embodiment of the invention, the spacer has a beneficial double or preferably even triple function. It keeps the lens element at a predetermined axial distance from the functional element; it constitutes the EMC shielding, or a part thereof; optionally it protects the inner space of the device and any elements therein from environmental influences during manufacture and use by forming a closed cavity in combination with the lens and base substrate portion. The conductive material is preferably chosen such that it is optically non-transparent, thus resulting in a spacer which is non-transparent or comprises a non-transparent coating, for example. This allows reduction or blocking of stray light that would otherwise enter the module through its side surfaces (via the transparent substrate portions). Consequently, a separate enclosure just for suppression of unwanted light is not necessary (but still possible).

[0027] A further advantage of the present invention is that the spacer can be provided with a conductive material suitable for an EMC shield already during manufacture of the spacer,